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Chemical Survey

The Issues and Objectives Committee of the Washington Chapter of THE AMERICAN INSTITUTE OF CHEMISTS undertook to make a survey of the chemical profession in Washington, D. C. It was then found that there has been little material published concerning the professional aspects of chemistry from a statistical point of view, and therefore the committee decided to collect available facts about the profession as a whole, in addition to the professional statistics on the Washington area, and to assemble all of this information into one report.

This completed survey is published in this issue of THE CHEMIST, and because of its professional value as an undivided report, much of the regular departmental material scheduled for this CHEMIST has been omitted.

The membership of the committee which has prepared this splendid report consists of: Mr. A. L. Mehring, chairman; Dr. M. S. Anderson, Mr. M. J. Goss, Mr. F. O. Lundstrom, Dr. Benjamin Makower, Dr. L. N. Markwood, Dr. W. N. Noble and Mr. L. F. Rader, Jr. All of these members assisted either in formulating the original questionnaire which was sent to the members in the Washington area, by making suggestions, by assisting in the collection of material or by criticising the manuscript. Those whose names appear at the head of the report itself did most of the actual work.

We feel that this survey will be of great interest to all chemists, and that they will welcome this first appearance in one complete report of available material about the chemical profession. The survey is divided into two parts, the first a summary of important available data on chemists together with original information, and the second, a special study of the chemists in the Washington, D. C. area.

A Partial Survey of the Chemical Profession with Particular Reference to the Washington Chapter of The American Institute of Chemists

by **A. L. Mehring, F.A.I.C., F. O. Lundstrom, F.A.I.C. and L. F. Rader, Jr., F.A.I.C.**

Introduction

A SERIES of reports, which gave the results of a nation-wide survey of the engineering professions, was recently issued by the U. S. Bureau of Labor Statistics.[1] These reports give valuable information on a wide variety of conditions affecting the members of each of the engineering professions, including chemical engineers. Surveys of physicians and of other professional groups have also been made by their own members and found useful.

One of the objectives of THE AMERICAN INSTITUTE OF CHEMISTS is to improve the economic status of chemists. No steps to accomplish this can be taken intelligently without knowledge of present conditions. Very little information respecting the professional side of chemistry has been published and this is widely scattered in the literature. An effort was made, therefore, to induce the Bureau of Labor Statistics to make a survey of the chemical profession, but without success. The Issues and Objectives Committee of the Washington Chapter of THE AMERICAN INSTITUTE OF CHEMISTS then decided to undertake such a survey, which must be somewhat limited in scope, however, because of lack of time and funds. The work consisted of two parts, (1), a general survey in which the more important available data on chemists are brought together and original information added, and (2), a special study of chemists in Washington, D. C. and vicinity.

1 Fraser, Andrew, Jr. Education in the Engineering Professions, Bull. R-400, 16 pp. Employment in the Engineering Profession 1929-1934, Bull. R-543, 16 pp. Income and Earnings in the Engineering Profession 1929-1934, Bull. R-588, 34 pp. U. S. Bureau of Labor Statistics. 1937.

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PART I

General Survey

CONSIDERABLE information about the chemical profession is scattered through the reports of the U. S. Census of Occupations for 1910, 1920, and 1930. The 1940 census will not be ready for publication until about the end of 1941. It will contain for the first time figures on salaries and incomes in addition to the data summarized below.

At the time of taking the last three censuses, there were in the United States the following numbers of chemists, assayers and metallurgists:

Year	Men	Women	Total
1910	15,694	579	16,273
1920	31,227	1,714	32,941
1930	45,163	1,905	47,068

These figures do not include chemical engineers. The tabulation shows an extremely rapid growth of the chemical profession during the period involved.

The age of chemists in 1930 was distributed in the manner shown in Table 1. The average age was calculated from the figures in this table to be 32.8 years.

The race of chemists in the United States in 1930 is shown in Table 2.

Table 1. Age of U. S. Chemists in 1930.

Years	Per cent
Under 20	3.78
20 — 24	22.47
25 — 29	21.79
30 — 34	16.64
35 — 39	12.77
40 — 44	7.91
45 — 49	5.37
50 — 54	3.80
55 — 59	2.40
60 — 64	1.59
65 — 69	.80
70 and over	.58
Age unknown	.10
Total	100.00

Table 2. Number of Chemists in the United States in 1930 by Race.

Race	Men	Women	All	Per cent of Total
Native White	39,747	1,694	40,441	85.92
Foreign-born White	5,932	195	6,127	13.01
Negro	347	14	361	.76
Mexican	56	1	57	.12
Japanese	25	0	25	.06
Chinese	21	1	22	.05
Filipino	18	0	18	.04
Indian	4	0	4	.01
All Others	13	0	13	.03
Total	46,163	1,905	47,068	100.00

Chemical Industry

In an industrial survey made in 1925 by the National Industrial Conference Board[2] data were obtained from 142 plants in the chemical industry employing 35,000 people. There were a total of 7,597 such plants with 247,173 employees in the United States at that time. These 142 plants employed 5,511 persons in major technical and supervisory positions, of whom 1,007 were graduate chemists and chemical engineers employed in the following capacities:

Presidents	16
Vice-presidents	14
Secretaries and treasurers	12
General managers	12
Works managers	36
Division managers	21
Other general officers	11
Engineers	39
Development department employees	36
Laboratory employees	459
Production superintendents	95
Supervisors	77
Foremen and Inspectors	17
Sales managers	37
Salesmen, etc.	78
Miscellaneous	47
Total	1,007

2 Technical Education and the Chemical Industry. Publication of the N.I.C. Bd. New York, 1-11 (1925).

White[3] found in a survey made in 1931 for the American Institute of Chemical Engineers that seventy per cent of chemical engineering graduates were employed by industrial organizations. The study included 1,112 graduates of five schools selected as representative of conditions in the U. S. The type of employment of members of various classes one year and ten years after receiving their bachelor's degrees is shown in Table 3. These figures indicate that about twice as many persons were taking graduate work in the later period. They also show that a large proportion of the recent graduates start work as analysts and then gradually switch to other types of employment.

The distribution of all chemists and chemical engineers in the United States between the various industries is given in Table 4. These figures were obtained from the U. S. Census of Occupations for 1930.

Table 3. Percentage of All Graduates in Various Types of Employment One and Ten Years After Receiving the Bachelor's Degree.

Type of Employment	Classes 1910-15	Classes 1920-30	
	One year	One Year	Ten Years
Graduate study	16.9	34.2	1.2
Teaching	11.4	5.2	10.8
Analytical chemistry	36.9	16.5	4.6
Research	13.0	12.6	19.2
Semi-plant development	4.3	7.1	7.5
Plant operation	8.7	13.5	22.1
General engineering	1.1	4.9	11.7
Sales	4.3	1.8	13.7
Miscellaneous	3.4	4.2	9.2
Total number of graduates	92	771	120

3 Occupations and Earnings of Chemical Engineering Graduates. A. H. White. Trans. A. I. C. E. *27*, 221-52 (1931).

Table 4. Numbers of Chemists and Chemical Engineers in Various Industries.

Industry	Chems.	Chem. Eng.
Agriculture	69	
Coal Mining	130	1
Copper Mining	161	1
Gold and Silver Mining	102	1
Iron Mining	201	1
Lead and Zinc Mining	76	1
Other Mining	91	1
Mining unspecified	268	1
Quarrying	32	1
Oil and Gas Production	296	1
Salt Production	50	1
Building	48	1
Charcoal and Coke	150	36
Explosives	387	77
Fertilizers	164	14
Gas	321	108
Paint	1,260	94
Petroleum Refining	3,079	515
Rayon	548	54
Soap	437	46
Other chemical	10,916	1,107
Cigar and Tobacco	37	
Brick and Tile	171	1
Glass	201	23
Lime	906	
Marble	15	
Pottery	231	1
Felt hat	12	
Clothing	16	
Bakeries	86	13
Dairy	484	10
Candy	57	
Flour Mill	397	
Canning	122	
Meat Packing	289	14
Sugar Refining	502	28
Other Food	711	33
Beverage	232	
Agricultural Implement	53	1
Automobile	595	67
Blast Furnace	3,002	1
Car and R. R. Shop	48	
Ship Building	26	
Other Machine Building	1,273	1
Consultants	4,293	
Amusement	76	9
Hotel and Restaurant	21	
Laundry	33	
Other Iron and Steel	643	82
Brass Working	202	
Clock and Watch	32	
Copper Refining & Mfg.	334	51
Gold and Silver Mfg.	99	
Jewelry	28	
Lead and Zinc Mfg.	327	49
Tin Ware	172	22
Other Metal Working	298	53
Leather Belt	54	
Shoes	58	
Tanneries	250	12
Furniture	32	
Saw Mill	31	12
Other Wood Working	91	24
Paper Mills	1,015	149
Paper Bags, etc.	58	
Paper Box	12	
Printing and Publishing	90	10
Carpet	34	
Cotton Goods	124	
Knitting	97	
Rope	12	
Silk	200	14
Textile Dyeing, etc.	396	13
Woolen Goods	85	
Other Textile	423	20
Button	13	
Power and Light	276	52
Electric Goods	785	177
Rubber	1,018	165
Turpentine	32	13
Miscellaneous Mfg.	1,036	121

(Continued on following page)

(Table 4—Continued)

Industry	Chems.	Chem. Eng.	Industry	Chems.	Chem. Eng.
Mfg. unspecified	1,159	119	Whole. and Retail Trade	1,505	29
Road Building	70		Other Commerce	16	
Street Railway	14		Government	2,045	
Steam Railroad	275	30	Cleaning and Dyeing	92	
Telephone and Telegraph	92		All Other	521	
Grain Elevator	15		Industry unspecified	166	
Insurance	50				
Cold Storage	16	10	Totals	47,068	3,475 [1]

1 The chemical and metallurgical engineers in the mining industries were included with mining engineers and those in a few other industries with other engineers. The total number of chemical engineers as shown is, therefore, somewhat too low.

It should be observed that the figures in Table 4 do not include apprentices and helpers in chemical work, nor do they include teachers of chemistry, although teachers of advanced chemical courses must necessarily be chemists. The figures in Table 4 undoubtedly include persons with some training in chemistry doing routine chemical work but who could not qualify as professional chemists.

The National Research Council[4] has published lists of research laboratories, containing, among other information, the numbers of chemists, engineers, botanists, assistants, etc., employed in each. The following facts about American industrial research were determined principally from this source.

Research laboratories of all kinds are operated by 1,768 companies. Most of these concerns have only one laboratory, but a number of large corporations maintain several. The largest number is 18. The total number of all laboratories is 2,220, of which 1,625 employ one or more chemists. The number of chemists doing research is 12,150. Some of these, however, devote a part of their time to routine analysis, plant operation or development work. The exact number of chemists was not stated for a relatively small number of laboratories, and estimates were made for these. This introduces an error of perhaps plus or minus 50 in the total. The numbers of chemical and metallurgical engineers were also stated in many cases but in a large number of other instances only

4 Industrial Research Laboratories of the U. S. including Consulting Research Laboratories. 6th ed. Callie Hull. Nat. Res. Council Bull. *102*, 1-270 (1938).

the total of all engineers was given. Where it was not given the number of each kind of engineer was estimated from the nature of the business and character of research carried on. Thus it appears that about 2,100 chemical engineers and 400 metallurgical engineers are also employed in research. It was also estimated that about 1,300 highly specialized chemists, such as metallurgists, ceramatists, and petroleum technologists, in addition to those given above are likewise employed in industrial research. These latter figures are liable to be in error by as much as twenty-five per cent of their value. Of the total of 1,625 industrial laboratories engaged, at least in part, in chemical research, 1,440 are operated in connection with factories, railroads, mines, stores, trade associations, etc., for the benefit of the organization involved and 185 are consulting laboratories catering to the public on a fee basis. The consulting laboratories employ 645 chemists who do research work. None of the figures in this paragraph, as far as known, includes control laboratories, routine analysts, or sub-professional assistants.

Federal Government Chemists

The August 1940 issue of the *Federal Employee* contains an account of a study by A. C. Edwards and Benjamin Wermiel on the occupations of government employees. According to this study, which is based on one-quarter of the service records in the Civil Service Commission, the Federal government employs 1,450 chemists and metallurgists. This is 0.18 per cent of all employees.

More than half of the chemists employed by the United States Government are engaged in research on problems of public health, agriculture, national defense, natural resources, and the general welfare. Almost without exception these problems are of great importance to the country and their solution probably would not be undertaken at all if the Federal government did not do it. About a quarter of all government chemists are employed in the enforcement of laws such as the Food and Drug Act, the Meat Inspection Act, Import Tariffs, Alcohol tax laws, etc. About ten per cent do analytical work on purchased supplies, or in connection with the manufacture of coins, ordnance, munitions, etc., and the remainder serve as patent examiners, civil service examiners, consulting experts to various officials, etc.

The numbers of chemists employed by the several government bureaus and establishments were obtained by consulting the respective personnel officers. The results by grades and establishments are given in Table 5

and are believed to be complete. These figures include persons of professional grade doing work based principally on training in chemistry, such as certain assayers, metallurgists, patent examiners, commodity experts, technologists, etc., regardless of their official title. They do not include chemical engineers, sub-professional workers in chemistry, nor graduate chemists now employed in other work. The numbers of chemical engineers are given in Table 6.

About half of the government chemists are employed in Washington, D. C., or its vicinity and the remainder are scattered throughout the country. Therefore, the numbers in Washington and environs were determined separately because these are of special interest to the Washington Chapter. The results are given in Table 7, which shows that 765 chemists are employed by the Federal government in this area. The chemists at government laboratories near Washington, such as the National Research Center at Beltsville, Maryland, and the National Institute of Health at Bethesda, Maryland, are included, but those in the Customs House at Baltimore and points further away are not. The numbers in Tables 5, 6, and 7 can be considered correct only for the day they were recorded due to subsequent appointments, resignations, promotions, etc. This date varied with the different bureaus, but in most cases it was in the summer months of 1940.

The U. S. Government also employs a total of 45 teachers of college chemistry in the U. S. Naval, Military and Coast Guard Academies, and in Howard University.

Table 5. Number of Chemists[1] in Each Grade Employed by the United States Government in the United States by Bureaus and Establishments.

Grades	P 1	P 2	P 3	P 4	P 5	P 6	P 7	P 8	Total
Titles and Salary Ranges / *Bureau*	Jr. Chem. $2000-$2600	Asst. Chem. $2600-$3200	Assoc. Chem. $3200-$3800	Chem. $3800-$4600	Sr. Chem. $4600-$5400	Prin. Chem. $5600-$6400	Head Chem. $6500-$7500	Chief Chem. $8000-$9000	$2000-$9000
Agricultural Chemistry and Engineering	23	20	35	23	41	21	7	1	171
Agricultural Marketing Service	2	1	1	—	1	—	—	—	5
Alcohol Tax Unit	1	21	10	16	2	1	—	—	51
Biological Survey	—	—	1	—	—	—	—	—	1
Animal Industry	14	11	13	3	7	2	—	—	50
Chemical Warfare Service	26	14	10	6	4	3	1	1	65
Civil Service Commission	3	1	1	2	1	—	—	—	8
Coast Guard	—	2	—	—	—	—	—	—	2

(Continued on following page)

(Table 5—Continued)

Bureau	Grades Titles and Salary Ranges	P 1 Jr. Chem. $2000-$2600	P 2 Asst. Chem. $2600-$3200	P 3 Assoc. Chem. $3200-$3800	P 4 Chem. $3800-$4600	P 5 Sr. Chem. $4600-$5400	P 6 Prin. Chem. $5600-$6400	P 7 Head Chem. $6500-$7500	P 8 Chief Chem. $8000-$9000	Total $2000-$9000
Customs		7	11	17	9	5	2	—	—	51
Dairy Industry		1	10	8	—	5	—	—	—	24
Engineers		2	2	1	—	—	—	—	—	5
Engraving and Printing		—	—	1	—	1	—	—	—	2
Entomology		3	8	10	6	5	1	—	—	33
Experiment Stations		2	1	3	—	1	—	—	—	7
Federal Bureau Investigation		4	3	4	4	—	—	—	—	15
Fisheries		6	4	1	2	—	—	—	—	13
Food and Drug Administration		50	61	44	18	17	7	1	—	198
Foreign and Domestic Commerce		—	—	2	—	1	1	—	—	4
Forest Service		3	5	2	5	5	4	—	—	24
Geological Survey		11	2	10	1	1	1	—	—	26
Government Printing Office		4	—	2	1	1	—	—	—	8
Home Economics		6	2	4	3	3	—	—	—	18
Mines		37	35	22	17	10	5	1	—	127
Mint		1	10	5	—	7	—	—	—	23
Narcotics		—	1	1	—	—	—	—	—	2
National Advisory Council for Aeronautics		—	1	2	—	—	—	—	—	3
National Archives		2	—	—	—	—	—	—	—	2
National Institute of Health		17	8	7	6	5	4	2	—	49
National Museum		—	2	—	—	—	—	—	—	2
Navy Department		44	83	32	18	2	1	—	—	180
Ordnance		9	10	3	2	1	1	—	—	26
Panama Canal		2	2	2	2	—	—	—	—	8
Patent Office		7	17	6	25	8	7	—	—	70
Plant Industry		11	25	16	9	12	2	—	—	75
Public Roads		2	—	4	—	—	—	—	—	6
Quartermaster Corps		4	2	—	—	—	—	—	—	6
Reclamation		2	2	1	—	—	—	—	—	5
Soil Conservation		—	—	1	—	1	—	—	—	2
Standards		45	44	15	15	14	8	1	—	142
Tariff Commission		—	—	1	2	3	1	—	—	7
Tennessee Valley Authority		22	9	5	1	2	—	—	—	39
Treasury Department, All other		—	—	—	1	1	1	—	—	3
Veterans Administration		—	—	3	1	—	—	—	—	4
War Department, All other		4	2	2	1	1	—	—	—	10
Total		377	432	308	199	168	73	13	2	1572

1 Including 70 patent examiners, 8 microanalysts, 52 metallurgists and assayers, and 14 commodity, clinical or other experts doing work based on professional training in chemistry.

Table 6. Number of Chemical Engineers in Each Grade Employed by the United States Government in the United States by Bureaus and Establishments.

Titles and Salary Ranges	P 1 Jr. Chem. Eng. $2000-$2600	P 2 Asst. Chem. Eng. $2600-$3200	P 3 Assoc. Chem. Eng. $3200-$3800	P 4 Chem. Eng. $3800-$4600	P 5 Sr. Chem. Eng. $4600-$5400	P 6 Prin. Chem. Eng. $5600-$6400	P 7 Head Chem. Eng. $6500-$7500	P 8 Chief Chem. Eng. $8000-$9000	Total $2000-$9000
Bureau									
Agricultural Chemistry and Engineering	4	4	2	3	3	4	—	—	20
Chemical Warfare Service	13	7	8	10	1	2	—	—	41
Civil Service Commission	4	—	—	—	—	—	—	—	4
Engineer Corps	10	1	1	—	—	—	—	—	12
Federal Power Commission	1	—	—	—	—	—	—	—	1
Mines	14	6	3	2	1	—	—	—	26
Ordnance	1	—	3	—	—	—	—	—	4
Plant Industry	—	1	1	—	—	—	—	—	2
Signal Corps	—	1	—	—	—	—	—	—	1
Standards	2	1	2	—	—	—	—	—	5
Tennessee Valley Authority	17	6	2	2	1	2	—	1	31
Total	66	27	22	17	6	8	—	1	147

Table 7. Number of Chemists of Each Grade Employed by Government Bureaus and Establishments in Washington, D. C. and Vicinity.

Titles and Salary Ranges	P 1 Jr. Chem. $2000-$2600	P 2 Asst. Chem. $2600-$3200	P 3 Assoc. Chem. $3200-$3800	P 4 Chem. $3800-$4600	P 5 Sr. Chem. $4600-$5400	P 6 Prin. Chem. $5600-$6400	P 7 Head Chem. $6500-$7500	P 8 Chief Chem. $8000-$9000	Total $2000-$9000
Federal Bureau									
Agricultural Chemistry and Engineering	12	10	21	15	21	8	3	1	91
Agricultural Marketing Service	2	1	1	—	1	—	—	—	5
Alcohol Tax Unit	1	1	2	5	2	1	—	—	12
Animal Industry	11	6	7	2	7	2	—	—	35
Chemical Warfare	—	—	1	—	1	—	—	—	2
Civil Service Commission	3	1	1	2	1	—	—	—	8
Customs	—	—	1	—	—	1	—	—	2
Dairy	1	10	8	—	5	—	—	—	24
Engineer Corps	—	1	1	—	—	—	—	—	2
Engraving and Printing	—	—	1	—	1	—	—	—	2
Entomology	—	7	6	5	4	1	—	—	23
Experiment Stations	—	—	2	—	—	—	—	—	2

(Continued on following page)

(Table 7—Continued)

Titles and Salary Ranges	Grades	P 1 Jr. Chem. $2000-$2600	P 2 Asst. Chem. $2600-$3200	P 3 Assoc. Chem. $3200-$3800	P 4 Chem. $3800-$4, 60	P 5 Sr. Chem. $4600-$5400	P 6 Prin. Chem. $5600-$6400	P 7 Head Chem. $6500-$7500	P 8 Chief Chem. $8000-$9000	Total $2000-$9000
Federal Bureau										
Federal Bureau of Investigation[1]		4	3	4	4	—	—	—	—	15
Fisheries		5	3	1	1	—	—	—	—	10
Food and Drug Administration		12	18	20	11	13	6	1	—	81
Foreign and Domestic Commerce		—	—	2	—	1	1	—	—	4
Geological Survey		8	1	8	1	1	1	—	—	20
Government Printing Office		4	—	2	1	1	—	—	—	8
Home Economics		6	2	4	3	3	—	—	—	18
Mines		5	6	3	1	1	1	1	—	18
Miscellaneous Treasury		—	—	—	1	2	1	—	—	4
Narcotics		—	1	1	—	—	—	—	—	2
National Archives		2	—	—	—	—	—	—	—	2
National Institute of Health		6	6	7	6	4	3	2	—	34
National Museum		—	2	—	—	—	—	—	—	2
Navy Department		8	26	15	5	1	1	—	—	56
Patent Office		7	17	6	25	8	7	—	—	70
Plant Industry		10	17	15	4	12	2	—	—	60
Public Roads		2	—	4	—	—	—	—	—	6
Soil Conservation		—	—	1	—	1	—	—	—	2
Standards		36	44	14	15	13	8	1	—	131
Tariff Commission		—	—	1	2	3	1	—	—	7
Veterans Administration		—	—	1	—	—	—	—	—	1
District of Columbia Dept.										
Health Department		—	—	1	—	1	—	—	—	2
Sewage Treatment		—	1	1	—	—	—	—	—	2
Water Service		1	—	1	—	—	—	—	—	2
Total		146	184	164	109	108	45	8	1	765

1 Including a few chemists in administrative (CAF) grades equivalent to the professional (P) grades shown.

State Chemists

All of the states and territories employ some chemists. Considerable numbers are engaged in teaching in state colleges. These numbers were determined from the catalogs of the various institutions and it was found that 1,214 are employed by state universities, 559 by state agricultural colleges, and 331 by all other state colleges, such as teachers' colleges, schools of mines, military schools, etc. All state colleges listed by the U. S. Office of Education were included. It was assumed

that every teacher of chemistry with an academic degree in a state college of any kind is a chemist. The numbers of chemists employed in agricultural experiment stations were determined from the compilation of Agnew.[5] The numbers in Table 8 include a few additional chemists employed in state experiment stations other than agricultural. The chemists of most experiment stations are engaged in research. A few do regulatory work in control of the sale of fertilizers, feeds, drugs, gasoline, etc. In most states, however, this work is done in the State Department of Agriculture or in the Laboratory of the State Chemist. The Highway and Health Departments as well as miscellaneous departments and commissions, varying widely in character from state to state, and too numerous to classify easily, also employ chemists. The rosters of members of various state organizations as well as the membership lists of the American Chemical Society, the American Institute of Chemical Engineers, and THE AMERICAN INSTITUTE OF CHEMISTS were consulted and checked against each other to learn the number employed in such agencies in each state. It is possible that some chemists may have been missed in a few cases and therefore the numbers shown as employed by miscellaneous agencies in some states may be too small.

Table 8. Number[1] of Chemists Employed by States and Territories by Classes of Institutions.

State or Territory	Universities and Colleges[2]	Experiment Stations	Executive Departments	Total
Alabama	31	6	4	41
Alaska	2	—	—	2
Arizona	7	8	—	15
Arkansas	14	4	3	21
California	106	18	18	142
Colorado	62	3	2	67
Connecticut	9	13	7	29
District of Columbia	2	—	6	8
Delaware	11	4	4	19
Florida	15	12	15	42
Georgia	33	5	16	54
Hawaii	8	5	—	13
Idaho	13	4	1	18
Illinois	171	9	15	195

(Continued on following page)

5 Agnew, Mary A. *Workers in Subjects Pertaining to Agriculture in Land Grant Colleges and Experiment Stations.* Dept. Agr. Misc. Pub. 299, Office of Expt. Stas. 1-140 (1938).

(Table 8—Continued)

State or Territory	Universities and Colleges[2]	Experiment Stations	Executive Departments	Total
Indiana	164	19	—	183
Iowa	118	13	9	140
Kansas	62	10	5	77
Kentucky	22	15	8	45
Louisiana	53	1	7	61
Maine	14	12	1	27
Maryland	42	—	4	46
Massachusetts	24	12	13	49
Michigan	93	10	18	121
Minnesota	80	14	8	102
Mississippi	15	4	5	24
Missouri	35	6	4	45
Montana	12	4	4	20
Nebraska	20	5	5	30
Nevada	11	1	1	13
New Hampshire	17	6	4	27
New Jersey	44	14	13	71
New Mexico	8	3	2	13
New York	19	19	25	63
North Carolina	44	4	18	66
North Dakota	10	4	4	18
Ohio	142	6	9	157
Oklahoma	31	5	1	37
Oregon	21	6	4	31
Pennsylvania	71	13	14	98
Puerto Rico	19	9	6	34
Rhode Island	18	7	1	26
South Carolina	17	7	6	30
South Dakota	14	2	1	17
Tennessee	18	12	3	33
Texas	76	15	8	99
Utah	12	4	3	19
Vermont	15	7	3	25
Virginia	21	4	23	48
Washington	31	7	3	41
West Virginia	45	5	7	57
Wisconsin	155	15	6	176
Wyoming	8	5	2	15
Totals	2,105	396	349	2,850

1 The numbers of chemists given in this table should be taken as minimum values. It is believed that in most cases they are complete tabulations, but some omissions may have occurred. This table does not include 146 chemical engineers also employed by state governments.

2 Privately controlled colleges and universities excluded. Chemists employed as teachers in high schools are included with the county and city chemists, which are discussed in the next section.

Of the total of 2,850 state chemists, 110 are employed in several capacities. In a few instances the same person teaches in a state college, does research work in the agricultural experiment station and assists in enforcing control laws. It would be necessary to correspond with all of these persons to determine exactly how they should be allocated in Table 8. Since this task could not be undertaken under the circumstances, they were placed in what seemed the most likely category.

It will be noted that the numbers of chemists given in this table as employed in state colleges of some of the Atlantic Coast states are much smaller than would be expected from their populations. This is due to the fact that a larger proportion of the colleges in the older states are church or privately endowed institutions not under direct state control.

County and City Chemists

Cities and counties employ chemists chiefly to control sewage disposal and water purification plants, to check the quality of purchased supplies and to teach in high schools. A check of all available sources of information revealed that at least 72 cities and 9 counties or sanitary districts employ 189 chemists and chemical engineers in chemical work. This number should be considered as a minimum, because some were probably not listed in the sources consulted. City controlled universities employ 167 chemists and 25 chemical engineers. High school and junior college teachers of chemistry who are members of one of the three chemical organizations mentioned above, excepting junior members of the American Chemical Society, number 278. All of these may be assumed to be chemists. There are hundreds of other teachers of chemistry in high schools. A few of these are probably graduate chemists but most of the remainder are merely teachers who have qualified to teach high school chemistry.

Education

Nearly all colleges and high schools in the United States employ one or more chemistry teachers. Of those teaching in colleges, universities, and technical schools, practically all are college graduates that have majored in chemistry. These, therefore, are professional chemists but most high school teachers of chemistry are not.

There are about 5,300 teachers of chemistry and chemical engineering in the colleges and universities of the United States. As shown above, 2,200 are employed in state controlled colleges, 200 in city controlled colleges, and 45 in colleges controlled by the United States. This leaves about 2,850, who are employed by privately controlled colleges. In addition there appear to be about 300 graduate chemists employed as

teachers in junior colleges and high schools. Of the members of the American Chemical Society, 4,607 are teachers of chemistry.

According to Badger, Kelly and Greenleaf[6] the total enrollment in chemical engineering courses in 760 colleges in the 1935-36 year was 10,167 undergraduates and 578 graduates. The number of undergraduate students in arts and sciences colleges majoring in chemistry is unknown but probably exceeds 40,000. In 1935, 3,159 graduate students majoring in chemistry or chemical engineering were enrolled in the colleges of the United States, according to West and Hull.[7] Of these 1,411 were working for the Master's degree and 1,748 for the Doctor's degree. The number of graduate students majoring in chemistry and chemical engineering in 1926 was 1,882 and in 1930 was 2,795. From 1928-32, inclusive, Ph.D.'s in chemistry were awarded to 1,434 candidates and Ph.D.'s in chemical engineering to 133.

In 1930, 24 per cent of college teachers of chemistry had a Bachelor's degree, 36 per cent a Master's degree and 40 per cent a Doctor's degree.

Salaries

In a survey conducted by the U. S. Bureau of Labor Statistics,[8] 3,270 graduate chemical and ceramic engineers and 177 non-graduates reported earned income. The median income in 1929 was $3,803 and in 1934 was $2,047. In 1929, 10 per cent earned more than $9,103 and 10 per cent less than $1,686. In 1934 the corresponding decile incomes were $5,860 and $610. In 1929 the median earnings of first degree graduates in chemical and ceramic engineering with the length of service were as follows:

Years After Graduation	Median Earnings
33-40	$6,450
25-32	6,600
17-24	6,429
13-16	6,021
9-12	4,523
5-8	3,544
3-4	2,729
1-2	2,007
0	1,200

From records of 134 graduate chemical engineers on file in the Massachusetts Institute of Technology, Anable[9] found that the median

6 Statistics of Higher Education 1935-36. H. G. Badger, F. J. Kelly, and W. J. Greenleaf. Bull. 1937 No. 2, 351 pp. (1938).
7 The Twelfth Census of Graduate Research Students in Chemistry. C. J. West and C. Hull. J. Chem. Ed. *13*, 339-43 (1936).
8 Income and Earnings in the Engineering Profession 1929 to 1934. Andrew Fraser, Jr. Bur. Labor Stat. Serial No. R-588, 1-34 (1937).
9 What of the Future for Chemical Engineering Graduates. A. Anable, Chem. & Met. Eng. *42*, 306-9 (1935).

salary increased from $1,500 to start, to $3,100 five years after graduation, and to $6,500 twelve years after graduation.

Starting salaries for chemists declined rapidly during the depression. This is shown by the average results of a survey by Elliott[10] as follows:

Year Graduated	1928	1929	1930	1931	1932	1933	1934
Number of Persons	8	16	19	18	46	25	38
Starting Salary	$1,710	$1,970	$1,755	$1,300	$1,135	$1,225	$1,138
1934 Salary	2,125	2,020	1,838	1,490	1,325	1,290	1,138

The earnings of chemical engineers that graduated from 1920 to 1930 were studied by White.[11] He obtained the median salaries of those with a Bachelor's degree as shown in Table 9. During the first year after graduation teachers and analysts received slightly less than the others, but all classes of chemical engineers received about the same salaries. Ten years later, however, the average sales promoter was receiving about double the average salary of the analysts. The median earnings for the entire group increased with length of service in the same way as those in Fraser's study. The figures for those taking graduate work showed no marked benefits in salary as a result of this additional study.

Table 9. Median Salaries of Chemical Engineers Graduated from 1920 to 1930.

Type of Employment	Years After Graduation			
	1	2	5	10
Teaching	$1,500	$1,600	$2,100	$3,200
Analysis	1,600	1,800	2,400	3,000
Research	1,800	2,000	2,700	3,800
Development	1,800	2,000	2,800	3,400
Plant Operation	1,800	1,900	2,800	4,000
General Engineering	1,800	1,800	3,100	4,100
Sales	1,800	2,200	3,300	5,500
All	1,800	1,900	2,700	4,100
Number of Persons	417	493	382	101

10 Purdue Surveys Its Graduates. E. C. Elliott. Chem. & Met. Eng. *42*, 309 (1935).

11 Occupations and Earnings of Chemical Engineering Graduates. A. H. White. Trans. A. I. Chem. Eng. *27*, 221-52 (1931).

Frazier[12] found that in 1930 the median annual salary of 152 college professors of chemistry located in 45 different states was $4,172, that of 92 associate professors was $3,304, of 128 assistant professors was $2,825, of 182 instructors was $2,035 and of 187 part time assistants was $833. The median of the 741 full time teachers was $2,904. In addition to salaries 22 per cent of these teachers had other earnings from consulting practice, royalties on books, etc., with a median of $321 annually. These results check closely with those of McNeely[13] who worked out the median salaries of 374 teachers of chemistry in 50 land grant universities and colleges for the 1927-28 academic year. His results, excluding part time assistants, are as follows:

Professors	Associate Professors	Assistant Professors	Instructors	All
$4,133	$3,289	$2,699	$2,000	$2,717

The range of salary extended from a minimum of $1,000 for an instructor to a maximum of $7,000 for a professor. The median for 22 women was $161 less per annum than that for 352 men.

No previous study of the salaries of chemists other than chemical engineers and teachers of chemistry has come to the attention of the authors.

Assuming that the Federal government chemists in each grade receive the average salary for that grade, and this is known to be a justifiable assumption, median and mean salaries were deduced from the figures in Table 5 and 6. The median salary of all government chemists is $3,200. The mean is $3,447. The median and mean salaries of government chemical engineers are $2,700 and $3,178, respectively.

Organizations of Chemists

The societies that are primarily composed of chemists may be divided according to their principal characteristics into the following classes: (1), scientific, (2), professional, and (3), social organizations. This division, however, is not sharp, because some of these organizations have features that identify them with more than one class.

The largest and by far the most important society of the scientific class is the American Chemical Society (frequently referred to as the A. C. S.). Formerly anyone interested in chemistry could become a member of the A. C. S., but since 1933 only college graduates that have

12 Present Status of Teacher Training in the U. S. Ben W. Frazier. J. Chem. Ed. *8*, 63-83 (1931).

13 Salaries in Land-grant Universities and Colleges. J. H. McNeely. U. S. Office of Education. Pamphlet No. 24, 1-27 (1931).

had three years of experience in chemical work are admitted to senior membership. Those with less training or experience are now accepted as junior members. Most of the organizations listed in Table 10 have more than one class of membership but accept as senior members only fully qualified chemists. The associations of cereal chemists, textile chemists, and leather chemists all have some active members who are not chemists.

Only two associations belong to the professional class. These are THE AMERICAN INSTITUTE OF CHEMISTS (A.I.C.), and the Association of Consulting Chemists. Table 10 also gives some facts regarding membership in these societies.

Table 10. Number of Members of Scientific and Professional Organizations of Chemists by Classes of Members.

Name	Senior or Active	Associate	Junior & Student	Corporation	Total	Foreign
American Association of Cereal Chemists	626	0	0	0	626	61
American Association of Textile Chemists and Colorists	1,771	262	287	33	2,353	53
American Chemical Society	21,517	0	2,948	598	25,063	1,671
American Electrochemical Society	1,221	0	0	35	1,256	321
American Institute of Chemical Engineers	1,355	167	744	0	2,266	71
American Institute of Chemists	1,341	114	166	0	1,621	9
American Leather Chemists Association	240	198	0	0	438	41
American Oil Chemists Society	472	17	0	27	516	19
American Society of Biological Chemists	533	0	0	0	533	28
Association of Consulting Chemists and Chemical Engineers	52	0	0	0	52	1
Association of Official Agricultural Chemists	1,500(a)	0	0	0	1,500(a)	150(a)

(a) Partly estimated.

The numbers of members of the various national associations of chemists were determined from the latest official membership lists. The numbers of members in the different classes and also those living

abroad were counted separately. Naturally some duplication of membership occurs between societies and this was determined by comparing the names on the various rosters. The results of these comparisons show that fifty-seven per cent of the members of THE AMERICAN INSTITUTE OF CHEMISTS also belong to the American Chemical Society. The corresponding percentage of A.I.C. members who belong to other societies are as follows: American Institute of Chemical Engineers 8, American Electrochemical Society 3, American Oil Chemists Society 2, American Society of Biological Chemists 2, Association of Consulting Chemists 1.3, and American Leather Chemists Association 0.5 per cent. Thirty per cent of the members of the A.I.C. do not belong to any other society in this group. The A.C.S. includes in its membership, excluding foreigners and corporations, 84 per cent of the members of the Association of Consulting Chemists, 60 per cent of the members of the American Society of Biological Chemists, 58 per cent of those of the American Institute of Chemical Engineers, 51 per cent of those of the Oil Chemists Society, etc. Eight-five per cent of the members of the A.C.S. do not belong to any of the other societies listed in Table 10. The total number of duplications of membership is 2,100.

The class of organizations of chemists, whose function is largely social, includes the Alpha Chi Sigma and Phi Lambda Upsilon fraternities, and The Chemists' Club. Each of these organizations has some professional and scientific aspects in addition to their social features. According to H. L. Marshall, secretary of the Washington Professional Chapter, Alpha Chi Sigma has about 14,000 members of whom not more than one-third are members of other societies of chemists.

A few other organizations have considerable numbers of chemists among their members, but their objectives have a general scientific or professional character. Examples of these are the Federation of Architects, Engineers, Chemists, and Technicians and the Association of Hawaiian Sugar Technologists.

PART II

The Washington Chapter, A.I.C.

IT WAS determined from the membership roll that the Washington Chapter has 122 fellows, 3 life members, 7 associates, and 11 junior members, making a total of 143, of which 6 are women. Of the total, 8 are consultants in private practice, 62 are employed by the United States government, 3 by city or state government, 35 by manufacturers, 27 by educational institutions, 3 by railroads and 1 by the Carnegie Institution. This leaves 4 either unemployed or with employer unknown.

Additional information was sought from the members by sending out questionnaires in the spring of 1940. Seventy-five completed forms were sent in but it was impossible to follow up the remainder. The titles of the members and the percentage returns from each class are summarized in Table 11. Since the returns were only 52 per cent of the total number of members, it was essential to determine whether or not they constituted a representative sample of the entire membership. Four statistical tests were made of the data and the results indicate that the returned questionnaires are from a representative sample of the membership. It was concluded, therefore, that the returned questionnaires merit further analysis. The results of this analysis follow under various headings. The figures as given should not be applied to chemists as a whole. They may be accepted as reasonably correct only for the chemists belonging to the Washington Chapter, A. I. C., who are not an average group of chemists, as will appear from the figures that follow.

Age

The age of the 75 members reporting varies from 24 to 70 with an average of 43.2± 0.8 years. The distribution by ages is given in Table 12. For comparison similar data for all government chemists are also given.

Table 11. Numbers of Members with Various Titles and Numbers of Returns from Each Class.

Title	Number of Members	Number of Questionaires Received	Percentage Returns
Junior Chemist and Laboratory Assistant	10	8	80
Assistant Chemist	14	8	57
Associate Chemist	12	6	50
Chemist	25	12	48
Section Chief			
Senior Chemist, etc.	12	9	75
Division Chief, Principal Chemist, etc.	10	7	70
Director, President, Partner,			
Bureau Chief, General Superintendent, etc.	24	11	46
Instructors	7	2	29
Professors and Assistant Professors	17	9	53
Deans and Heads of Chemistry			
Departments	7	3	43
Totals	138	75	54
Title Unknown	5	0	
Grand Total	143	75	52

The latter figures were very kindly supplied by Benjamin Wermiel from records in the Civil Service Commission and include the field service as well as the departmental service at Washington. The average age of the government chemist is 41 as compared with 43 for the Chapter members. It was found in the 1930 census that the average age of all chemists in the United States was 33 years.

The average ages of control and analytical chemists that are members of the Washington Chapter is 33.2 ± 1.0, of research chemists is 41.3 ± 1.2, of teachers is 46.1 ± 2.1, of consultants is 46.8 ± 2.6, and of executives and administrators is 47.7 ± 1.4 years.

Dependents

Of the 75 chemists reporting in this survey 10 are single, 1 is a widower and 64 are married. The number of dependents varies from none to 5, with an average of 1.51 ± 0.09. Only 4 of these members have more than 3 dependents. Three of the single persons report an average of 1.7 dependents each and 13 of the married ones have no dependents. Twelve married members report only one dependent each. The above facts indicate that about half of the members have no children but that a part of the dependents reported consists of persons other than wives and children of the members, such as parents and

other relatives. This is partly offset by the fact that some children of the older members are self-supporting and were therefore not given as dependents.

The questionnaire did not ask for the number of children and therefore a check up was made of as many members as possible from the personal knowledge of the members of the committee, with the results shown in Table 13.

Table 12. Age Distribution of Chemists in Two Groups

Age	All U. S. Government Chemists		Members of Washington Chapter Reporting	
	Number	Per cent of Total in this Group	Number	Per cent of Total in this Group
20 - 24	35	2	2	3
25 - 29	110	8	6	8
30 - 34	290	20	9	12
35 - 39	245	17	8	11
40 - 44	275	19	18	24
45 - 49	225	15	11	14
50 - 59	270	19	16	21
60+			5	7
Total	1,450	100	75	100

Table 13. Number of Members with Different Numbers of Children.

Number of Children	Members	Per cent of Total
None	58	52
1	16	14
2	22	20
3	8	7
4	6	6
5	1	1
Average and Totals 1.02±0.08	111	100

Education and Degrees

Three of the members taking part in this study have no academic degrees. One of them is a graduate of a chemistry course in a technical school that confers no degrees and the other two have completed the

major portions of college courses in chemistry, but never graduated. The highest degree received by the others is as follows:

Degree	Number Holding
A.B.	4
B.S.	14
Ph.B.	1
M.A.	7
M.S.	11
L.L.D.	1
Ph.D.	32
D.Sc.	2

Although the proportion of doctors among chemists as a whole is not known it is certain that the proportion among the members of the Washington Chapter is extraordinarily high. The proportions of chemical engineers holding various degrees were determined by the Bureau of Labor Statistics as mentioned above. These proportions are compared in Table 14 with the corresponding figures for the chemists of the Washington Chapters.

Twenty persons or 26 per cent of those reporting have completed various advanced courses in chemistry in addition to the work for which they received their most advanced degree. This additional work ranged from a few post-graduate courses to three full years of advanced work and averaged about thirty semester hour credits. Two members reported holding two doctorate degrees each.

The undergraduate preparation for the profession of chemist is far from being standardized, as is shown by the following figures:

First Academic Degree Received	Number Reporting
B.S.	38
A.B.	20
B.S. in Chem.	4
Ph.B.	2
B.Ch.E.	2
B.Chem.	1
Ph.G.	1
B.S. in Chem. Eng.	1
Not stated	3
Total	72

Table 14. Number of Chemists in the Washington Chapter and of Chemical Engineers in the U. S. Holding Various Academic Degrees.

Degree	Chemists Wash. Chapter Number	Chemists Wash. Chapter Per cent	Chemical Engineers Number	Chemical Engineers Per cent
None	3	4.0	177	5.0
Bachelor[1]	19	25.3	2807	80.0
Master[1]	18	24.0	411	11.8
Doctor	35	46.7	112	3.1
Not reporting	0	.0	5	0.1
Total	75	100.0	3,512	100.0

[1] Or equivalent engineering degree

Table 15. Age Distribution at Beginning of Career in Chemistry and Highest Degree Held at Present.

Age	Degree				Total Persons
	None	Bachelor	Master	Doctor	
18	—	—	—	1	1
19	—	—	—	1	1
20	—	3	—	3	6
21	—	5	1	4	10
22	1	3	3	5	12
23	1	1	4	6	12
24	1	2	4	4	11
25	—	—	1	4	5
26	—	3	2	3	8
27	—	1	1	—	2
28	—	1	—	3	4
29	—	—	—	—	0
30	—	—	1	—	1
31	—	—	—	1	1
32	—	—	1	—	1
Average Age	23.0	22.9	24.5	23.4	23.51 ± 0.21

Employment

The ages at which the present group started their careers, with their present academic degrees, are given in Table 15. This table shows that a considerable part of those in each group were already launched in their chemical careers before finishing their formal education. On the other hand about one-third of the members started in chemical work at a later age than would be expected unless some time was lost

in the process of education or in obtaining employment in the practice of chemistry. The Master's degree was obtained one year after the Bachelor's in only 18 cases out of 47 reported. The longest elapsed time between these two degrees was 13 years and the average time 3.2 years. In ten out of thirty-one cases the Doctor's degree was received in two years or less after the Master's degree. The longest and average elapsed times were 23 years and 4.5 years, respectively.

In the group under discussion, 59, or 79 per cent, have been employed only in chemical work since starting their careers, and 16 or 21 per cent have been otherwise employed for periods varying from 6 months to 14 years with an average of 3.7 years. The world war was the cause of the interruption in seven cases.

Fifty-nine of the 75 reporting have been employed continuously since starting to work, one gave up a position to attend a graduate school, one is retired and 14 have been without employment after beginning their careers for periods varying from two months to four years. Seven were without work for less than four months, four from four to eleven months and three for one year or more. Eleven lost their positions in the depression years of 1907, 1920 and 1932-34. Only three cases of unemployment occurred among this group in all other years combined. Only one person was out of a position more than once. Forty-eight or 64 per cent have never been employed outside of their field of professional work and have never been unemployed since starting to earn their living. Five, or 6.7 per cent have been both out of employment and employed in other pursuits.

Field of Activity

The fields of activity of the entire membership have been enumerated in the introduction. Of those who returned questionnaires, thirty-nine are in the government service, fourteen are in manufacturing, thirteen in education, four in consulting work, three in transportation, one is a graduate student and one is in an endowed research institution.

The numbers of chemists with professional ratings employed by various government bureaus and other institutions in the District of Columbia or vicinity are given in Table 16. This table indicates the total numbers of chemists in each field of activity in this area. For comparison the numbers that are members of various societies are also given. The numbers of members of the Washington Chemical Society in each field were determined from a classified list of the members in effect on October 10, 1940.

The kind of employment of the seventy-eight members of the Washington Chapter, A. I. C. reporting is as follows:

Administration	23
Consultation	5
Regulation	3
Research	34
Routine analysis	3
Teaching	8
Graduate studies	1
Engineering	1

In some cases a chemist had more than one function and could have been classed in either of two groups, usually administration and research. In such cases the person was placed in the group that seemed most logical from the title and salary. It will be observed that the membership of the Chapter includes a very large proportion of executives and administrators.

Table 16. Number of Chemists and Chemical Engineers in the Washington Area and of Members of Five Societies by Field of Activity.

Field of Activity	Total Number	Members of Wash. Chem. Soc. No.	Amer. Inst. Chem. No.	Amer. Soc. Biol. Chem. No.	Amer. Inst. Chem. Eng. No.	Elec. Chem. Soc. No.
Federal Government						
Agriculture						
Bur. Agr. Chem. and Eng.	101	60	33	3	2	1
" Animal Industry	35	22	4	2	0	0
" Dairy Industry	24	18	3	4	0	0
" Entomology and P. Q.	23	12	1	1	0	0
" Home Economics	18	15	0	1	0	0
" Plant Industry	62	52	15	1	0	0
Food and Drug Admn.	81	30	1	5	0	0
All Other	9	11**	0	0	0	0
Civil Service Commission	12	4	0	0	0	0
Commerce						
Bur. For. and Dom. Com.	4	1	3	0	0	1
" Standards	134	100	6	2	1	5
Patent Office	70	3	0	0	0	0
All Other	3	1	0	0	0	0
Government Printing Office	8	1	0	0	0	0
Interior						
Bur. Fisheries	10	7	1	0	0	0
" Mines	24	16	0	0	1	1

(Table 16—Continued)

Field of Activity	Total Number	Wash. Chem. Soc. No.	Amer. Inst. Chem. No.	Amer. Soc. Biol. Chem. No.	Amer. Inst. Chem. Eng. No.	Elec. Chem. Soc. No.
Geological Survey	20	17	1	0	0	0
All Other	1	1	0	0	0	0
Justice						
Fed. Bur. Investigation	15	3	0	0	0	0
All Other	1	1	0	0	0	0
Labor	0	1**	0	0	0	0
National Institute of Health	34	47**	0	7	0	0
National Museum	2	4**	0	0	0	0
Navy	56	29	1	0	2	2
Tariff Commission	7	2	1	0	0	0
Treasury						
Bur. Internal Revenue	12	4	0	0	0	0
All Other	10	4	1	0	0	1
War	8	11**	0	0	0	0
All Other	11	2	1	0	0	0
D. C. Government	6	4	0	0	0	0
State Government	0	1	0	0	0	0
Education						
Colleges and Universities	106	101**	4	5	3	2
High Schools	22	5	0	0	0	0
Societies, Research Institutions, etc.						
American Chemical Society	3	3	0	0	2	0
American Pharmaceutical Assn.	2	2	0	0	0	0
Carnegie Inst., Geophysical Lab.	18	13	1	0	0	0
National Research Council	2	2	1	0	0	1
National Canners Assn.	5	6	0	0	0	0
Nat'l Paint, Varnish and Lacquer Assn.	6	2	1	0	0	0
All Other	11	11	2	0	3	0
Professional Consultants	26	16	4	0	3	3
Patent Attorneys	0	19**	0	0	2	3
Manufacturing and Commerce	35*	31	1	0	0	0
Public Utilities	5	2	0	0	0	0
Transportation	2	2	2	0	0	0
Retired	10*	6	1	0	0	0
Unclassified	10*	5	8	0	3	0
Total	1064	710**	97	31	22	20

* Partly estimated.

** Including a few persons, such as students, physicians, etc. interested in chemistry but primarily not chemists.

Table 17. Income From The Practice of Chemistry in 1939 by Length of Service

	Years of Service								
	0 to 4	5 to 9	10 to 14	15 to 19	20 to 24	25 to 29	30 to 34	35 and Over	Averages and Totals
Minimum Income	$1654	$1560	$1560	$2000	$2412	$3000	$3300	$4800	$1560
Maximum Income	2800	3800	8385	8500	10000	5600	6400	9600	10000
Median Income	2000	2350	3150	3900	4000	4150	4800	7250	3700
Mean Income	2051	2610	3656	3958	4308	4400	4552	6980	4000
Probable Error of Mean	±78	±206	±382	±479	±321	±275	±256	±537	±157
Number in Group	8	6	10	8	14	7	10	5	68

Income

Only 69 persons reported 1939 income from chemical work, distributed as follows:

0 — $1,999	5
$2,000 — 2,999	18
3,000 — 3,999	18
4,000 — 4,999	11
5,000 — 5,999	7
6,000 — 6,999	4
7,000 — 7,999	4
10,000+	2

The lowest income in 1939 among this group was $500, the highest $18,000, the median $3,700 and the mean $4,152±207. The standard deviation of the mean is $2,552. The minimum and maximum values both appear to be abnormal in comparison with the other values. An average was therefore calculated without the two extremes and this value is $4,000±157, with a standard deviation of $1,904. It is practicable to determine whether or not these extreme values are abnormal for so small a population in the following manner. If the distribution of the various salaries around the mean is normal and the first mean is correct, about two-thirds of all the values must fall within limits plus or minus the standard deviation of the mean, or between $1,600 and $6,704. As over ninety per cent are within these limits the extreme values are abnormal. Without them two-thirds of the salaries should fall between $2,100 and $5,900 and actually seventy-two per cent do, which is near

enough to the theoretical value to show that the other salaries are distributed in a normal manner. The accepted average is therefore $4,000± 157 and the two extreme values will be left out of all further calculations.

Of those members that have been employed more than ten years, 53 reported their incomes for 1929, 1934, and 1939. The averages are $3,584, $3,694 and $4,341, respectively. The average increase in salary or income then was only $110 in the five years from 1929 to 1934, but was $647 in the next five years.

The amount of income in 1939 is compared with length of service in Table 17. The 35 years and over group included an undue proportion of cases of high income and is clearly out of line with the other groups.

The income or salary during the first year of service in chemistry was given by 70 members. The smallest starting income was in the case of a bachelor of science who received $360 for the year 1932 and the largest was $2,940, obtained by a doctor in 1927. Nineteen, or 27 per cent started their careers at salaries of less than $1,000 per annum; 36, or 52 per cent, began at $1,000 to $1,999; and 15, or 21 per cent, received from $2,000 to $2,940 during their first year in the chemical profession. Only three started at less than $600 and only five at more than $2,500. The mean is $1,433, the median $1,200, and the mode $1,200. The averages by various groups are given in Table 18. The proportions of those with the various degrees are nearly enough alike in each time group so that this factor does not complicate the results.

The starting salaries of the two that have no degree were undoubtedly higher than average for this group in general. The 1939 incomes of those with various degrees were averaged separately and the results are shown in Table 19. The maximum income of $18,000 was received by a member with a bachelor's degree and the minimum of $500 was received by a Ph.D. These two incomes were not included in the averages for reasons already explained.

Table 20 gives information concerning the 1939 income from various fields of endeavor in chemistry. Since length of service and possession of a doctor's degree are factors in determining salaries, data relating to these factors are also given in this table. From these figures it appears that the average manufacturing company pays its chemists more, other factors being equal, than either government or educational institutions do. The latter two fields of service appear to be about equally attractive as far as monetary returns are concerned because the two averages are well within the probable errors of being the same.

Table 18. Average Income for First Year of Service in Chemistry by Groups of Chemists.

Group	Number in Group	Percentage of Doctors in Group	Average Annual Income
Starting before 1915	20	50	$ 911 ± 51
" 1915-1929	35	48	1699 ± 67
" 1930-1934	6	67	1560 ± 167
" 1935-1939	9	44	1481 ± 146
Having a Bachelor's degree	17	0	1326 ± 87
" " Master's degree	17	0	1317 ± 70
" " Doctor's degree	34	100	1524 ± 91
Without a degree	2	0	1810
Total	70	48.6	1433 ± 51

Table 19. Average 1939 Income of Chemists with Various Degrees.

Academic Degree	Number in Group	Average Service in Years	Average 1939 Income
None and Bachelor	17	19	$3479 ± 221
Master	18	19	3237 ± 170
Doctor	32	20	4706 ± 217
All	67	19	4000 ± 157

The 1939 income by type of service is given in Table 21. The average income of these executives in chemical work is nearly three times as large as that of the routine analysts. Those doing research work and teaching appear to be equally well paid as a whole and to receive incomes slightly less than midway between executives and analysts.

The salaries of 23 research chemists employed in Washington were obtained in addition to those of the members of the Washington Chapter, A.I.C. and those employed by the government. These vary from $2,400 to $5,200, annually, with an average of $4,007. The salaries of nine additional analytical chemists were also learned and these range from $1,380 to $3,000, annually, with an average of $1,809.

Benefits in Addition to Salary

Twenty-seven members receive no benefits or perquisites through their employment in addition to their salary or money income. On the other hand forty-eight stated that they receive other considerations of value in addition to their salary. One teacher receives free board and lodging.

five members receive free medical care, one has the free use of a company owned automobile, twenty-seven are given traveling expenses at rare intervals to attend scientific meetings, seven get free life insurance as long as they stay with the present employer, and one chemist receives cash bonuses of variable amount whenever the company makes extra profits. In addition most teachers may take graduate courses in their school without the payment of fees and nearly all chemists are given the privilege of having technical and scientific journals relating to their work circulate over their desks without cost to them. It is probable that all of these benefits together on the average are worth less than $50 annually per chemist, although in a very few cases they are certainly worth $200 or more per year.

Table 20. Income by Field of Service.

Field of Service	No. in Group	Average Years of Service	Percentage of Doctors	1939 Income		
				Minimum	Maximum	Average
Manufacturing	11	17	73	$2,000	$ 8,500	$4,969 ± 394
Personal Service	3	13	33	2,400	10,000	4,967 ± 1386
All Others	4	25	25	1,560	9,600	4,005 ± 1116
Government	38	21	37	1,654	8,500	3,746 ± 170
Education	11	22	73	2,350	6,000	3,646 ± 160
All	67	20	48	1,560	10,000	4,000 ± 157

Table 21. Income by Kind of Service.

Kind of Service	No. in Group	Average Years of Service	Percentage of Doctors	1939 Income		
				Minimum	Maximum	Average
Administration	21	27	76	$3,300	$ 9,600	$5,797 ± 209
Consultation	3	13	33	2,400	10,000	4,967 ± 1386
Research	27	19	33	2,000	5,400	3,283 ± 121
Teaching	8	20	75	2,350	4,600	3,263 ± 161
Regulation	3	17	0	1,560	3,400	2,173 ± 338
Analysis	5	6	0	1,654	2,716	2,022 ± 113
All	67	20	48	1,560	10,000	4,000 ± 157

Hours of Labor

The weekly hours of labor, reported by seventy chemists, varied from 20 to 100 with a mean of 41.9, a mode of 39 and a median of 39. Forty-four, or 63 per cent, work from 38 to 41 hours per week, inclusive. Only four, or 6 per cent, are employed less than 38 hours weekly, twelve, or

17 per cent, are employed 41½ to 50 hours each week and nine, or 13 per cent, are employed 51 to 60 hours, inclusive. The numbers of chemists working different numbers of days per week are as follows:

Days per Week Employed	Numbers of Chemists
5	7
5½	36
6	22
6½	2
7	4

Thirteen teachers reported that they were engaged in actually teaching on the average 18.0 hours weekly, the range being from 5 to 27 hours. One had no other official duties and one failed to mention hours spent in other duties. The remaining nine spend 25.0 hours weekly in other work relating to their official position. These hours vary from 3 to 40 per week. The length of teaching year varies from 8 months to 11½ months with an average of 9.2 months for thirteen reports. Eight teach 9 months yearly.

Vacations

Only four members do not take vacations or receive time off with pay and all of these are executives or owners of their own business. Three receive one week or less time off with pay, fifteen receive from 10 days to 2 weeks vacation, forty-three receive more than two weeks but not more than 1 month, and seven, all teachers, receive from 60 to 100 days vacation. The average vacation taken by the seventy-two reporting is 26.1 days. All government chemists are entitled to a total of 26 days annual leave with pay but several of these reported taking on the average considerably less than this number of days leave annually.

Miscellaneous Employment Conditions

In reply to the question, "Is your tenure of office protected?", twenty-one replied that it was not and thirty-eight that it was. Of the latter, thirty-one are protected by civil service rules and seven by employment contracts.

Fifty-four, or 75 per cent of the members reporting, will be entitled to retire on a pension for old age or disability. Eighteen have no provision for a pension. Of the former, fifty-three contribute from their salaries to pay for it either in whole or in part.

In reply to the query, "Is your work particularly hazardous?", four

replied "yes" and sixty-nine "no". Those that replied "yes" were requested to explain. Two failed to do so, one of the others explained that he is required to work with highly inflammable solvents and the fourth handles large quantities of strong acids.

Various questions were asked relating to protection from dangerous conditions wherever needed with four possible answers indicated in each case, as follows: "excellent", "good", "fair", and "poor". The first and second of these questions related to the removal of fumes and dust respectively, in the laboratory or other place of employment. The third asked the degree to which dangerous apparatus, machines or processes used in their work were provided with safety devices, and the last of these sought information on the provision of first-aid facilities in case of accident. The replies are summarized in Table 22.

In reply to the question, "Do you receive credit for your creative work?", forty-six wrote "yes" and nine "no". The seven in educational and industrial organizations that answered "no", explained that the results of their discoveries were the property of the organization and taken as a matter of course by the officials. Of the two in government service, one said and the other implied that the minor officials in charge of their work obtained credit for their ideas.

Table 22. Numbers of Chemists Whose Health Is Protected With Various Degrees of Perfection.

Health Protection	Excellent	Good	Fair	Poor	Total Number of Replies
Fume Removal	25	18	9	6	58
Dust Removal	16	16	7	5	44
Safety Devices	22	13	5	2	42
First Aid Facilities	18	19	14	9	60

Publications

Of the seventy-five members that replied to a query about authorship, only eighteen have never been an author of a publication. The other fifty-seven during the past ten years have published a total of 38 books, 91 bulletins, 582 scientific journal articles, and 53 miscellaneous articles, making a total of 764 or an average of 13.4 publications each. The miscellaneous class includes articles for popular magazines, newspapers, formal written lectures, etc. The numbers of authors of the different classes are as follows: books 19, bulletins 21, journal articles

48, all others 12. Sixteen persons are authors of over 20 articles each in this ten year period, but only three have credit for over 30. The largest number of publications in ten years is 68 by a division chief in the government service. It is possible that this member misunderstood the question and gave instead the number issued during his entire career.

Patents

A total of 110 patents have been issued to twenty-one different members of the Washington Chapter. Sixty-five of these patents were issued to ten persons as sole inventors and forty-five to thirteen members as joint inventors with others. Only two of the joint inventors hold any patents solely in their own names.

Conclusion

Scattered information about chemists, much of it in literature not readily accessible to the profession as a whole, has been summarized and is presented here together with some original data. It is hoped that the results of this work will be of value to the chemical profession, although it is realized that this survey has been fragmentary. It is believed, however, that enough has been done to demonstrate the need for still more information along the lines already laid down in this study.

Luciano L. Blancaflor

It is with deep regret that THE AMERICAN INSTITUTE OF CHEMISTS records the death of Luciano L. Blancaflor on August 24, 1940.

Mr. Blancaflor was born in Bangued, Philippine Islands, on June 30, 1896. He was educated at Temple University in Philadelphia from which he received the A.B. degree in 1926. From 1928 until the time of his death he was employed as chemist by E. J. Lavino and Company, Plymouth Meeting, Pennsylvania. He became an Associate member of THE AMERICAN INSTITUTE OF CHEMISTS in 1938.

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December Meeting

The one hundred and seventy-fifth meeting of the National Council of The American Institute of Chemists was held on December 18, 1940, at The Chemists' Club, 52 East 41st Street, New York, N. Y., at 6:30 o'clock P. M.

President Harry L. Fisher presided. The following officers and councilors were present: Messrs: E. R. Allen, Frank G. Breyer, Harry L. Fisher, Charles N. Frey, M. L. Hamlin, H. G. Knight, C. A. Marlies, Walter J. Murphy, H. S. Neiman, W. T. Read, G. E. Seil, N. A. Shepard, F. D. Snell, and A. H. Warth. Mr. M. R. Bhagwat, Dr. W. D. Turner, and Miss V. F. Kimball were present.

The minutes of the preceding meeting were approved. The Treasurer's report, covering the period from November 18, to December 18, 1940, showed total cash in bank and on hand of $4,712.52 with total bills payable of $327.57. Upon motion made and seconded, this report was accepted.

The Secretary announced that the total number of members is now 1,663.

Upon motion made and seconded, $100.00 was contributed to the Chemist Advisory Council.

The committee appointed to consider the Federal Wage and Hour Law ruling reported and presented a suggested petition for amendment of regulations, and after consideration and upon motion

made and seconded, the Council endorsed this petition in general, and requested the committee to continue its work and to contact other organizations.

Dr. W. T. Read reported progress for the Committee on Membership.

Dr. Read reported for the Chemist Advisory Council that letters had been sent out requesting coöperation from chemists.

Dr. Marlies suggested that the INSTITUTE organize committees in various sections of the country to form new chapters.

Mr. Breyer discussed the present employment situation.

Mr. Murphy suggested that the president of the INSTITUTE visit each chapter at least once every year. He also suggested that each chapter make an attempt to determine how many chemists are in its district, their distribution and the average salary maintained in that district.

It was also suggested that the INSTITUTE request access to the National survey of chemists now being made.

Upon motion made and seconded, the Secretary was requested to inform the chapters that the President of the INSTITUTE is available to talk before each chapter at least once during the season.

Dr. Turner reported for the Committee on Ethics that progress has been made on the application which was referred to it.

It was decided to hold the next meeting of the council on Wednesday, January 15, 1941. (Note: this date was later postponed to January 22, 1941).

There being no further business to come before the meeting, adjournment was taken.

CHAPTERS

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News Reporter to THE CHEMIST, Margaret C. Swisher

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Secretary-treasurer, Harold A. Heiligman
1203 West Oak Street
Norristown, Penna.

Council Representative, Gilbert E. Seil

News Reporter to THE CHEMIST, Kenneth A. Shull

THE November meeting of the Pennsylvania Chapter was held at the Randall Morgan Laboratory of Physics at the University of Pennsylvania on Tuesday, the 28th.

Prior to the main meeting an informal dinner was held at Houston Hall in honor of the speaker. At this time, Mr. J. M. McIlvain, administrative supervisor with the Atlantic Refining Company, presented a short talk on the various problems encountered in personnel work.

The principal speaker was Dr. G. P. Harnwell, head of the Physics Department at the University of Pennsylvania. His subject was "Nuclear Reactions", the essence of which follows:

Chemists are particularly interested in the outer electronic structure of atoms, inasmuch as these planetary electrons are the ones involved in chemical reactions. Physicists, on the other hand, are at present primarily concerned with the internal or nuclear structure. It is their aim to disrupt the nucleus in such a way as to produce an entirely different atom.

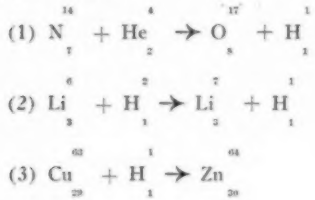
The discovery of radioactivity was the first instance of atomic disintegration. Through the emission of helium atoms (minus two electrons) radioactive elements are transmuted to different elements, which may or may not be radioactive. Energy changes accompanying such reactions are enormous when compared to those involved in chemical reactions. Thus it is necessary to subject atoms to the bombardment of particles possessing extremely high energies in order to transmute them artificially. Projectiles which have been used for this purpose include protons, neutrons, deuterons, alpha particles, and gamma rays.

Two pieces of apparatus have been developed in order to effect artificial transmutations: (1) the cyclotron, in which ions are caused to revolve in a circular path with increasing speed until they attain the required voltage, whereupon they are discharged against the material to be transmuted; and (2) the electrostatic generator, in which a moving belt conveys positive electrical charges from a source of current at the bottom of the instrument to an electrode at the top. When the electrostatic charge has been built up sufficiently it is caused to discharge against a suitable target. This latter apparatus has found considerable favor with workers in pure science.

Nuclear reactions may involve changes in atomic mass, in atomic number, or in both. Two types of elements may result: (1) Stable elements, and (2) transitory or radio-elements. These latter substances possess very short half lives—from a few seconds to several hours.

In the examples of nuclear reactions

which follow, the first substance in the equation is bombarded by the second. The subscripts refer to the atomic number and the superscripts to the atomic weight.


(1) $^{14}_{7}N + ^{4}_{2}He \rightarrow ^{17}_{8}O + ^{1}_{1}H$
(2) $^{6}_{3}Li + ^{2}_{1}H \rightarrow ^{7}_{3}Li + ^{1}_{1}H$
(3) $^{63}_{29}Cu + ^{1}_{1}H \rightarrow ^{64}_{30}Zn$
(4) $^{65}_{29}Cu + ^{1}_{0}n \rightarrow ^{66}_{29}Cu$
(5) $^{13}_{6}C + ^{2}_{1}H \rightarrow ^{11}_{5}B + ^{4}_{2}He$
(6) $^{4}_{2}He + ^{27}_{13}Al \rightarrow ^{31}_{15}P$

Several applications have been found for artificially created radioactive substances: (1) Since they have short lives they can be used therapeutically in the treatment of cancer, etc. without causing burns and other complications;

(2) By tagging certain compounds with radioactive elements, such as phosphorus, for example, and feeding them to animals it is possible, by periodic analysis, to determine the part that this element plays in bone structure;

(3) the "creep" of certain metals can be investigated by introducing certain radioactive atoms into the metal and observing their behavior.

At the close of Dr. Harnwell's interesting talk the group was given the excellent opportunity of inspecting the University's new electrostatic generator.

—K. E. SHULL

Washington

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Vice-president, L. F. Rader, Jr. *Treasurer,* L. R. Heiss

Secretary, Martin Leatherman
9 Quincy Avenue, Hyattsville, Md.

News Reporter to THE CHEMIST, T. H. Tremearne

Council Representative, Albin H. Warth

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America's first commercially built electron microscope is now being operated in the Stamford Laboratories of The American Cyanamid Company, according to a recent announcement made by the Company. This microscope makes it possible to photograph minute objects to a magnification of twenty to thirty thousand times their size. The details of these photographs are so sharp that they can be enlarged to give a total useful magnification of 100,000 times natural size. An object an inch long so magnified would appear to be more than a mile and one half in length.

The application of this instrument in the American Cyanamid Company is expected to uncover new and important facts about the action of catalysts, the action of chemicals on the bacteria of disease, and the nature of synthetic resins and the processes by which they are formed. This instrument was developed and built by the R.C.A. Laboratories in Camden, New Jersey.

Applications for Membership

Final action will be taken by the National Council, at its meeting on Wednesday, February nineteenth, on the following applications:

For Fellow:

Becher, Harold
Chief Chemist, Peerless Fur Dyers, Inc., 214 W. 26th St., New York, N. Y.

Cowen, Theodore
Lacquer Chemist, Baer Brothers, Stamford, Conn.

Hanzely, Edward M.
Analytical Chemist, Crown Cork and Seal Co., Inc., Highlandtown, Baltimore, Md.

Ross, John
Research Chemist, Colgate Palmolive Peet Co., Jersey City, N. J.

Shaffer, Sherman Simpson
Chief Chemist, Baytown Refinery, Humble Oil and Refining Co., Baytown, Tex.

Sutherland, Leslie Thompson
Chemical Advisor, The Barrett Company, 40 Rector St., New York, N. Y.

For Associate:

Melaccio, Frank
Plant Chemist, New York Quinine and Chemical Works, Inc., Brooklyn, New York.

To be Raised from Associate to Fellow:

Gordy, Edward L.
Technical Director, W. C. Hardesty Co., Inc., Dover, Ohio.

Opolonick, Nicholas
Chief Chemist, Hammond Paint and Chemical Co., Beacon, N. Y.

Royer, George Lewis
Supervisor, Micro Laboratories, American Cyanamid Company, (Calco Division), Bound Brook, N. J.

Russo, Michael
Control Laboratory Supervisor, New York Quinine and Chemical Works, Inc., Brooklyn, N. Y.

Whitney, William Bernard
Associate Professor, North Texas Agricultural College, Arlington, Tex.

EMPLOYMENT

Chemists Available

INSTRUCTOR in qualitative and inorganic chemistry. Two years' experience. Ch.E. degree. Wishes position in undergraduate school. Please reply to Box 123, THE CHEMIST.

CHEMIST, J.A.I.C., M.S. degree 1932. University of Michigan. Specialized in analysis. Several years of experience in various industries, notably steel. Desires work where precise knowledge is required. Also interested in teaching college chemistry. Location anywhere. Please reply to Box 125, THE CHEMIST.

CHEMIST, J.A.I.C. B.S. 1940. Six months' experience during summers in rubber factory. Fluent French and German. Interested in position as laboratory assistant or translator. Please reply to Box 55, THE CHEMIST.

COMMERCIAL DEVELOPMENT. Chemical engineer with twenty years of experience supervising research and development in petroleum refining seeks change. Please reply to Box 121, THE CHEMIST.

CHEMIST, F.A.I.C., experienced in chemical and pharmaceutical products, foods, specialties, etc. Able to handle analytical research, production and supervision. Miscellaneous pharmaceutical compounding, medicinal and chemical preparations a specialty. Writer is known for technical publications in the United States and abroad. Out of position on account of abandonment of plant with which he had been affiliated for ten years. Please reply to Box 11, THE CHEMIST.

Positions Available

CHEMIST. Supervisory experience in chemical manufacturing. Organic.

METALLURGIST. Under 30. Graduate recognized school. Five years of experience. Locate east.

CHEMIST. Under 40. Experienced in wood pulp or paper research and development.

CHEMIST. Know textile finishing chemicals for sales work.

CHEMICAL ENGINEER. Some experience in starches, gums, and adhesives for technical service work.

PH.D's., CHEMICAL ENGINEERS. Limited experience. Product research in experimental department. Process design and development.

PH.D. recent physical or organic chemist to work in Far East.

For these positions please reply to Box 12, THE CHEMIST.

CHEMIST, B.S., M. S., Age 41, wishes to promote new chemical product or add capital to growing concern requiring services of capable executive with successful business record. Prefer Philadelphia, New York, or vicinity. Please reply to Box 17, THE CHEMIST.

Evening Courses of the Washington Square College of Arts and Science of New York University will begin February 5th to 11th. Elementary and advanced courses are offered in biology, chemistry, languages, mathematics and physics, in addition to other courses.

For information address the Director of Evening Studies, New York University, Washington Square College, New York, N. Y.

In Memoriam

Dr. Joseph F. X. Harold,
January 3, 1940

Knight of the Table Round

Knights of the Table Round,* with jest
and laughter,
We close the ring of fellowship each
day,
Chaffing about what is to follow after—
But listen, while I speak of one away.

Josephus, many years your wit and
humor,
(Kindly philosophy, without a sting,
Though backed by facts or logic—or
by rumor),
Suffused good-fellowship throughout
our Ring.

We'll meet again, as one by one we
follow
The pioneering path you bravely trod;
Then, what we now call "future", will
seem hollow—
The past alone is what persists with
God.

—HIERONYMUS.

*The Round Table of The Chemists' Club, New York, N. Y.

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IF--THEN

F a smile upon my face will bring a smile to others, then will I be a benefactor to my friends.

F happiness begets happiness, then will I be the father of a million sons.

F pleasant words find echo in the hearts of those I know, then will I speak them more and more.

F joy brings happiness to those I meet, then will I sing my songs all day.

F hope brings courage to the faltering one, then will I tell my expectations to the world.

F I can do one thing to brighten up the life of someone else, then that one thing shall be the object of my life.

—H. S. N.

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